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(54) Abstract Title
Variable image refresh rate in a display

(57) A method of refreshing an image on a display device includes receiving an image to be displayed (810) at a display (110); processing said received image to obtain at least one image parameter (particularly colour) relating to said image to be displayed (810); and varying a rate (930) at which said displayed image is refreshed based on said image parameter.

This provides the following advantages that the refresh rate is constantly being varied in response to the images being displayed so as to constantly minimise the power consumption of the display device without noticeable flickering of the display device. Furthermore, the quality of the image is maintained at a continuous level, irrespective of the changes in, for example the complexity or number of colours used in a particular image.

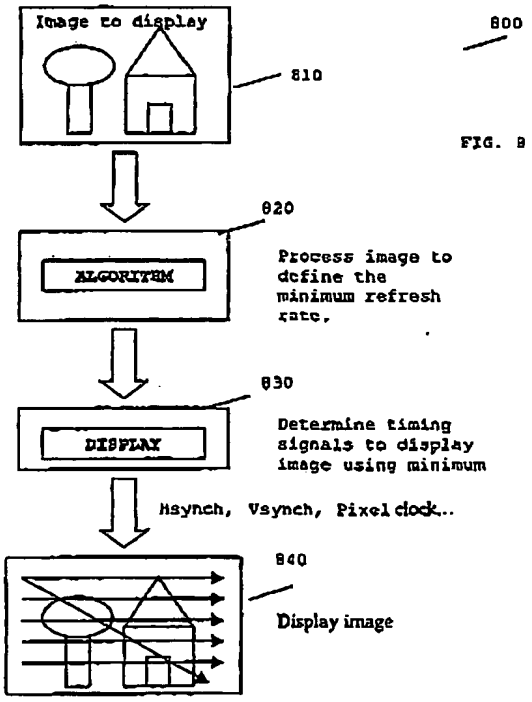

FIG. 8

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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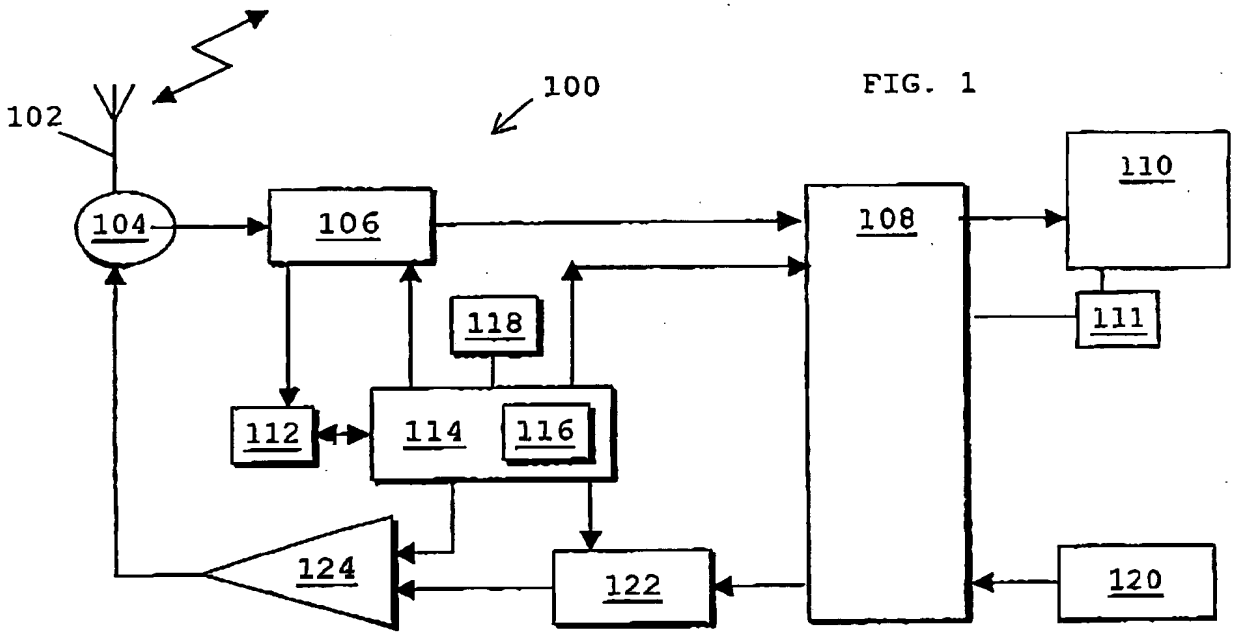

100
102
104
106
108
110
111
112
114
116
118
120
122
124

FIG. 1

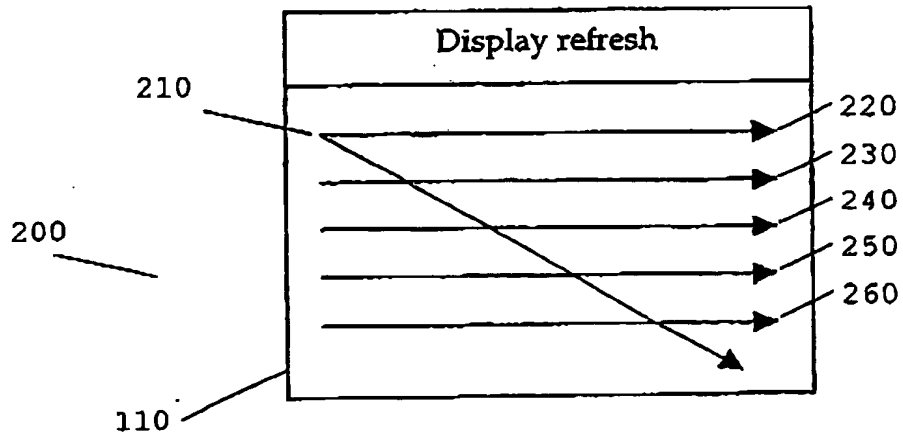
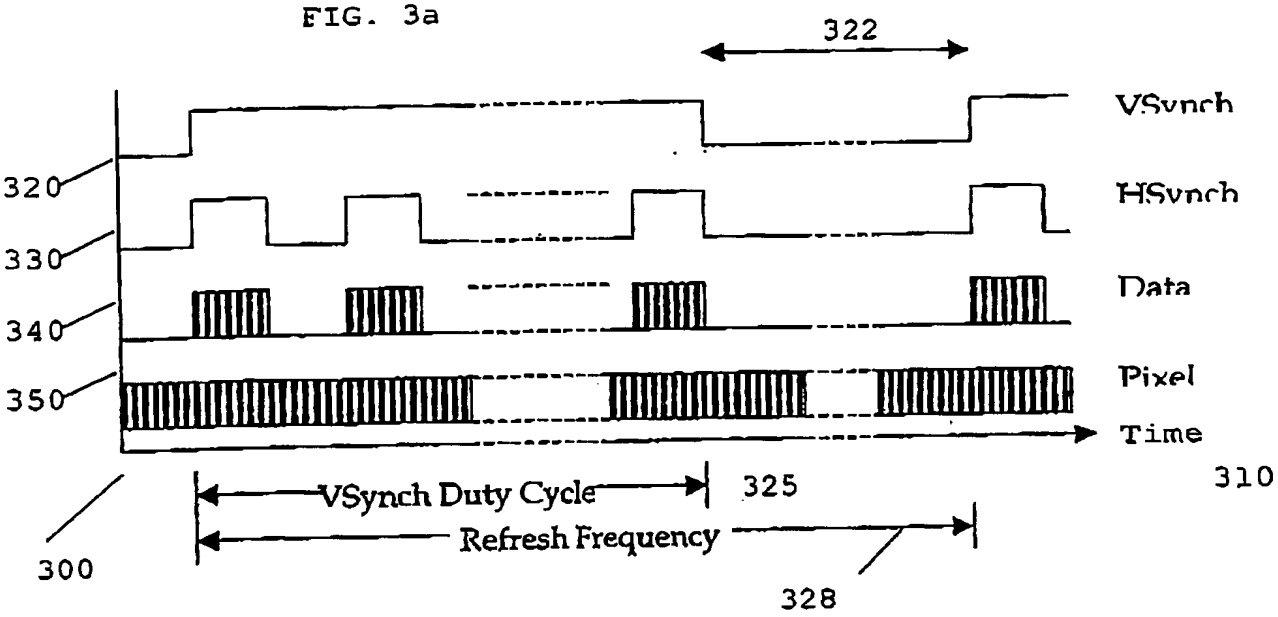

Display refresh
210
220
230
240
250
260
200
110

FIG. 2

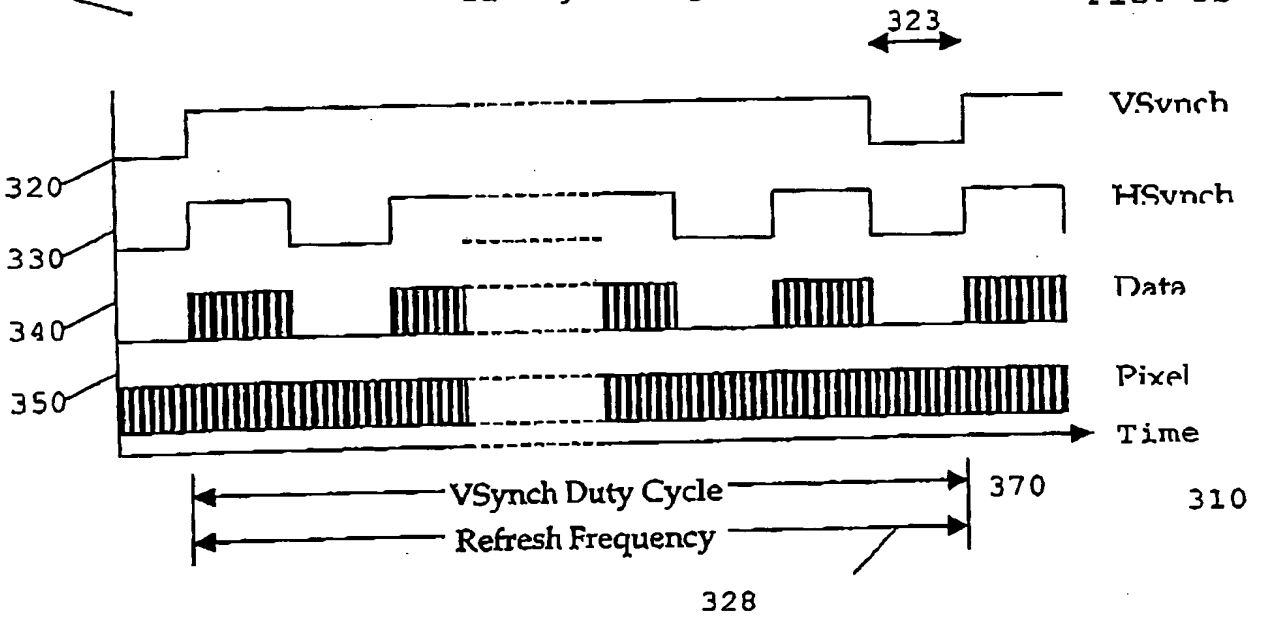
FIG. 3a



360

Timing of signals

FIG. 3b



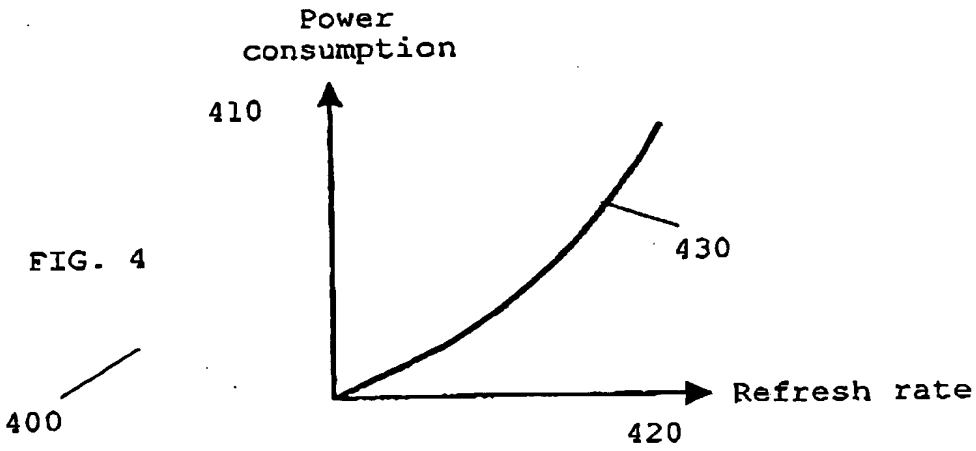

Power consumption
410
430
Refresh rate
420
400

FIG. 4

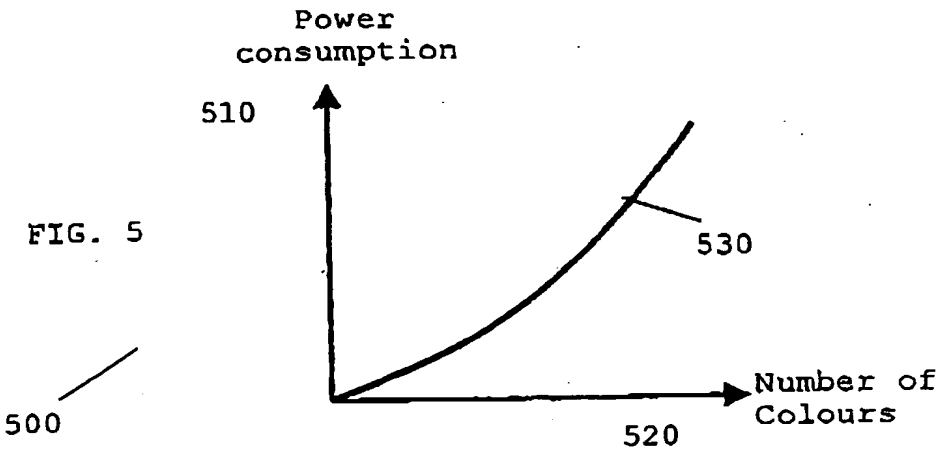

Power consumption
510
530
Number of Colours
520
500

FIG. 5

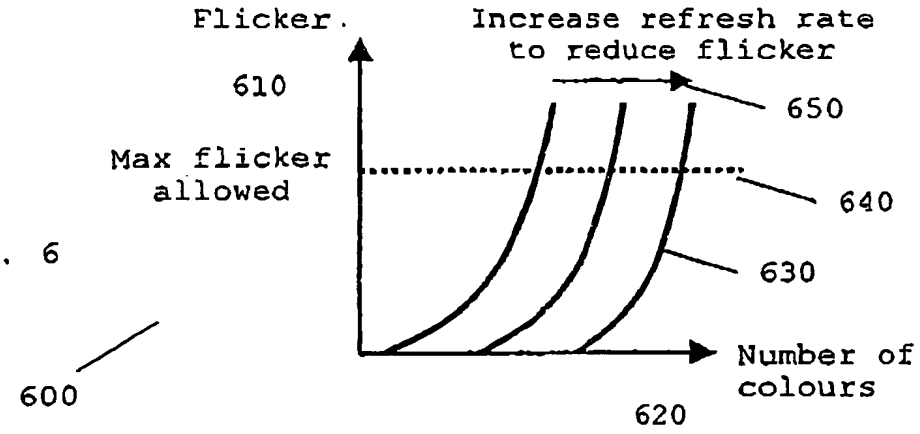

Flicker
Increase refresh rate to reduce flicker
610
650
Max flicker allowed
640
630
Number of colours
620
600

FIG. 6

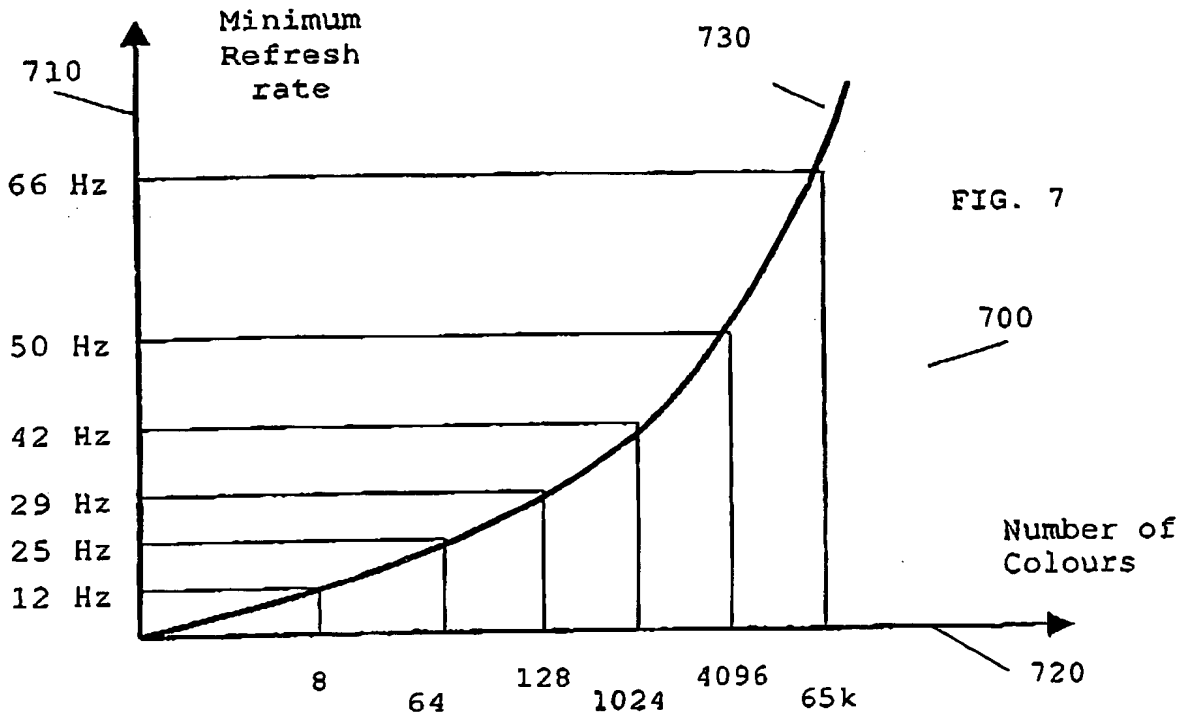

Minimum Refresh rate
710
730
66 Hz
50 Hz
42 Hz
29 Hz
25 Hz
12 Hz
8
64
128
1024
4096
65k
Number of Colours
720
700

FIG. 7

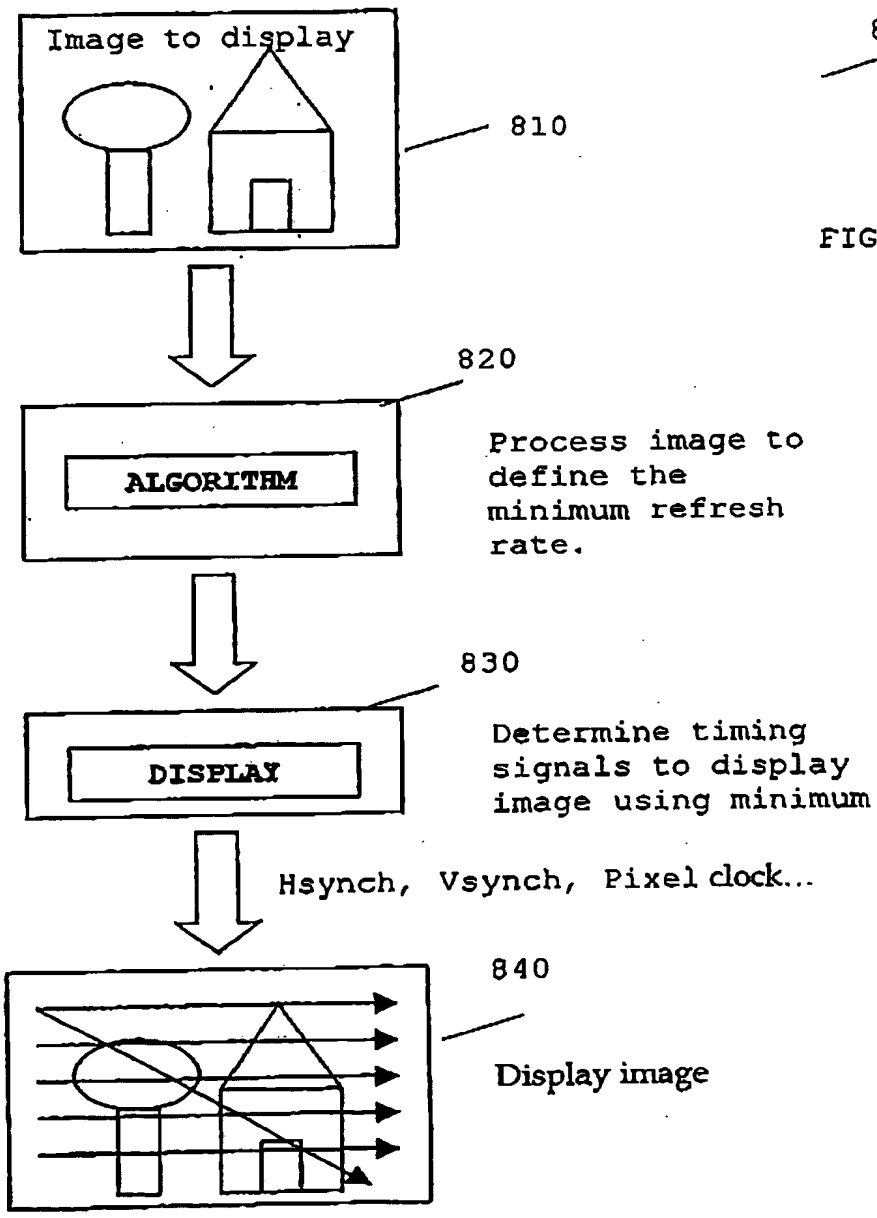


Image to display
800
810
820
ALGORITHM
Process image to define the minimum refresh rate.
830
DISPLAY
Determine timing signals to display image using minimum
Hsynch, Vsynch, Pixel clock...
840
Display image

FIG. 8

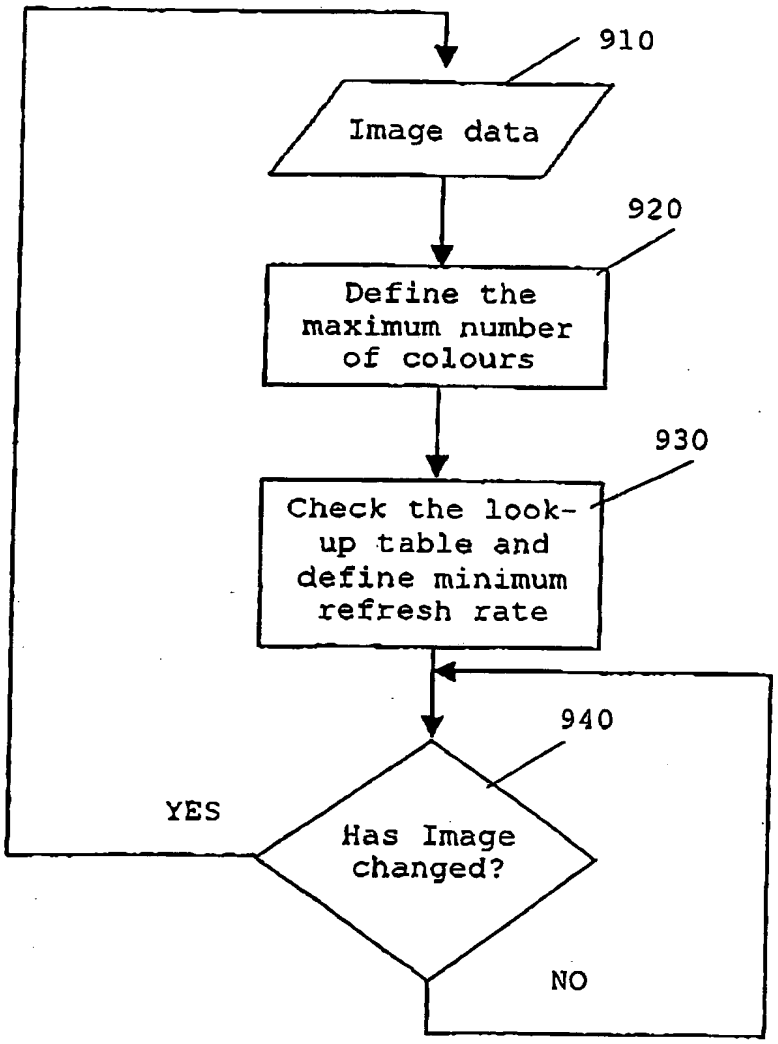

910
Image data
920
Define the maximum number of colours
930
Check the look-up table and define minimum refresh rate
940
Has Image changed?
YES
NO

FIG. 9

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IMAGE REFRESH IN A DISPLAY

Field of the Invention

This invention relates to a method of altering the rate at which a display device, such as a liquid crystal display (LCD), is refreshed. The invention is applicable to, but not limited to, display devices used in battery powered apparatus, such as personal digital assistants (PDAs) or mobile phones, where battery power to operate and refresh the display is limited.

Background of the Invention

Future generation mobile and fixed communication systems are expected to provide the capability for video and image transmission as well as the more conventional voice and data services. As such, video and image services will become more prevalent and improvements in video/image compression technology are likely to be needed in order to match the consumer demand within the available communication bandwidth.

Current transmission technologies, which are particularly suited to image or video applications, focus on interpreting image data at the transmission source. Subsequently, the interpretation data, rather than the image itself, is transmitted and used at the destination communication unit.

Such communication systems are often bandwidth constrained because of the communication channel. In constraining the amount of information to be transmitted between transmitting and receiving units, video and image compression techniques have been developed. The use of video and image compression techniques allows the system designer to optimise and prioritise the video signals and images that are to be transmitted.

One example would be to transmit interpretation data in compressed form. The ability for a video or image decoder in a communication device to only process interpretation data minimises the amount of processing required to recover a particular image or series of images. Consequently, the communication device is able to conserve battery power, which is of immense benefit in a portable communication device.

In the context of the present invention, and the indications of the advantages of the present invention over the known art, the expression 'image' is used to encompass various video techniques including video that is streamed or encoded (block-based, DCT-based, object-based or other) for storage with the ability to be viewed later and/or image transmission techniques including still image transmission.

In the field of this invention it is known that an image presented on a display device fades with time. Therefore

it is necessary for the image to be refreshed in order for it to remain clear to a viewer/user. If the refresh rate is not sufficiently high, the image degrades enough for the human eye to perceive the image degradation during a display refresh operation. Hence, a too-low refresh rate causes a perceptual flickering of the displayed image to the user.

Furthermore, the more colours that are used in a displayed image, the more noticeable that any flickering is to a user. Therefore, it is known that images with more colours often require a higher refresh rate than images with fewer colours.

However, the higher the refresh rate, the higher the power consumption. In particular, in order for a display device to continuously display images having many colours, the display is designed to have a constant high refresh rate, and thereby a constant high power consumption. Therefore, a display arrangement designer is left with a trade-off of perceived image quality versus power consumption.

Furthermore, this approach has the disadvantage that conventional apparatus use a display device that has such a fixed refresh rate. In order for there to be minimal perceptual flickering, this refresh rate must be fixed at the highest value in order for the most intricate images to be displayed. This means that the power consumption of the display device is constantly set to its highest level.

Thus there exists a need in the field of the present invention for an improved display arrangement wherein the abovementioned disadvantages associated with prior art arrangements may be alleviated.

Statement of Invention

In accordance with a first aspect of the present invention, there is provided a method of refreshing an image on a display device, as claimed in claim 1.

In accordance with a second aspect of the present invention, there is provided an image or video communication device, as claimed in claim 12.

In accordance with a third aspect of the present invention, there is provided a display driver for controlling a refresh rate of a display device, as claimed in claim 14.

In accordance with a fourth aspect of the present invention, there is provided a storage medium storing processor-implementable instructions, as claimed in claim 15.

In accordance with a fifth aspect of the present invention, there is provided a video or image display device, as claimed in claim 16.

In accordance with a sixth aspect of the present invention, there is provided a display driver for controlling the refresh rate of a display device, as claimed in claim 26.

Further aspects of the invention are as claimed in the dependent claims.

In summary, the present invention provides a means of varying the refresh rate of a display, dependent upon the image being displayed, in order to reduce the overall power consumption of a display device.

Brief Description of the Drawings

Exemplary embodiments of the present invention will now be described, with reference to the accompanying drawings, in which:

FIG. 1 shows a block diagram of a subscriber unit adapted to support the inventive concepts of the preferred embodiments of the present invention.

FIG. 2 shows a graphical illustration of a display refresh operation.

FIG. 3a and FIG. 3b show timing diagrams of a subscriber unit adapted to support the inventive concepts of the preferred embodiments of the present invention.

FIG. 4 shows a graphical illustration of power consumption versus refresh rate for a display refresh operation.

FIG. 5 shows a graphical illustration of power consumption versus a number of colours to be displayed for a display refresh operation.

FIG. 6 shows a graphical illustration of flicker versus a number of colours to be displayed for a display refresh operation.

FIG. 7 shows a graphical illustration of a minimum refresh rate versus a number of colours to be displayed for a display refresh operation, in accordance with a preferred embodiment of the present invention.

FIG. 8 shows a flowchart of a method of refreshing an image on a display device, in accordance with a preferred embodiment of the present invention.

FIG. 9 shows a flowchart of a more detailed method of refreshing an image on a display device, in accordance with a preferred embodiment of the present invention.

Description of Preferred Embodiments

The preferred embodiment of the present invention is described with reference to a portable cellular phone capable of operating in, for example, the next generation of wireless cellular technology. However, it is within the contemplation of the present invention that the inventive concepts described herein are equally applicable to any other video or image display device, such as a personal data assistant (PDA), a portable or mobile radio, a laptop computer or a wirelessly networked PC or indeed any other digital device supporting video/image transmissions.

Referring first to FIG. 1, there is shown a block diagram of a cellular subscriber unit 100 adapted to support the inventive concepts of the preferred embodiments of the present invention. The subscriber unit 100 contains an antenna 102 preferably coupled to a duplex filter or circulator 104 that provides isolation between receiver and transmitter chains within the subscriber unit 100.

The receiver chain, as known in the art, includes scanning receiver front-end circuitry 106 (effectively providing reception, filtering and intermediate or base-band frequency conversion). The scanning front-end circuit 106 is serially coupled to a signal processing function 108. An output from the signal processing function 108 is provided to a suitable output device 110, such as a screen or flat panel liquid crystal display.

The screen or flat panel display 110 preferably includes a display driver 111.

In the preferred embodiment of the present invention, each time an image on the screen or flat panel display 110 is to be refreshed, each pixel within the display device is typically refreshed, as illustrated in FIG. 2. FIG. 2 shows one example of a display refresh operation 200, in accordance with a preferred embodiment of the invention. Each pixel of the screen or flat panel display 110 is refreshed in a particular order, for example by starting at the top left corner 210 of the screen and refreshing each pixel row-by-row 220-260.

However, it is within the contemplation of the invention that alternative refresh procedures can be employed, such as when an interleaving operation is used. Such a procedure involves the alternate refreshment of odd and even horizontal lines (rows).

Referring back to FIG. 1, the receiver chain also includes received signal strength indicator (RSSI) circuitry 112, which in turn is coupled to a controller 114 for maintaining overall subscriber unit control. The controller 114 is also coupled to the scanning receiver front-end circuitry 106 and the signal processing function 108 (generally realised by a DSP) for receiving a transmitted video or image signal.

The controller 114 may therefore receive bit error rate (BER) or frame error rate (FER) data from recovered information. The controller is also coupled to a memory device 116 that stores operating regimes, such as decoding/encoding functions and the like. In accordance with the preferred embodiment of the present invention, the processor 108 and/or controller 114, together with the display driver 111, has/have been adapted such that a refresh rate of images displayed on the screen or flat panel display 110 is varied in response to the image being displayed.

It is within the contemplation of the invention that the inventive concepts described herein apply equally to images received by the communication unit, or previously stored within the communication unit for subsequent display. Indeed, the inventor of the present invention has recognised that a particular advantage of the inventive concepts results from displaying simple images, for example menus etc., that are likely to be included among the resources provided on the communication unit itself. In particular, when the communication unit, for example cellular phone, is in a standby mode of operation (i.e. switched on but not being used), there is frequently a basic image that is displayed on the display. This basic image, in standby mode, does not require a high refresh rate.

The generally assumed operational profile of a cellular telephony unit suggests that the unit is typically in an idle mode for 90% of its operating time and actively

involved in calls for the remaining 10% of its operating time. Cellular phone manufacturers publish figures for the "standby time" of their products, which equates to the ability of the battery to maintain its charge to sustain the cellular telephone in an idle mode of operation. Such figures are deemed as highly influential in attracting purchasers of cellular phone equipment.

Conversely in the private mobile radio field, a trunked radio is assumed to be in an idle mode for 75% of its operating time, in a receive mode (receiving broadcast, signalling, synchronisation transmissions etc.) for 20% of its operating time and transmitting/receiving in a call for 5% of its operating.

Hence, the inventive concepts of the present invention provide benefits when processing newly received images. In addition, the inventive concepts also allow a reduction in the power consumption of a display when in stand-by mode in, for example, either of the above communication products thereby substantially increasing the standby time of the product.

A timer 118 is operably coupled to the controller 114 to control the timing of operations (including transmission or reception of time-dependent signals) within the cellular subscriber unit 100. The timer, together with the display driver 111, processor 108 and/or controller 114, has also been adapted to control the refresh rate of the displayed image of the screen or flat panel display

110. The preferred operation is described in greater detail with reference to FIG. 3.

In accordance with a first embodiment of the present invention, the display refresh operation is controlled in response to a status of selected signal timings 310, as shown in the graph 300 of FIG. 3. The preferred embodiment of the present invention utilises timing of signals that include vertical synchronisation (VSynch) 320, horizontal synchronisation (HSynch) 330, data 340 and pixel clock 350, associated with the display in conjunction with the received video or image signal(s). The frequencies of Hsynch 330 and the pixel clock 350 are multiples of the Vsynch 320 frequency.

The Vsynch signal 320 is used to inform the display device 110 when to commence incorporating the next whole image or commence refreshing portions of the current image. The Vsynch signal 320 essentially controls when the vertical alignment of the refresh operation returns to the top of the display device, as shown by the top left hand corner 210 of FIG. 2. Thus, for the illustrated embodiment, the Vsynch signal 320 essentially sets a display refresh rate.

A preferred embodiment of the invention, as shown in FIG. 3a, uses the duty cycle 325 of the VSynch signal 320, namely a leading-edge pulse to re-commence refreshing the display, thereby setting a refresh duty cycle. However, a skilled artisan would recognise that alternative signal

timings and alternative triggering mechanisms, such as using a trailing-edge pulse, return-to-zero (RZ) pulses, etc. and an alternative display arrangement could still benefit from the inventive concepts described herein.

Once the refresh cycle reaches the bottom right hand corner of the display device 110, the display refreshing operation is paused 322 until the next leading-edge pulse of the VSynch signal 320. By controlling the time for which the display refreshing operation is paused 322, it is possible to vary the refresh rate of the display device 110.

The Hsynch signal 330 is used to inform the display device when to begin to draw the next horizontal line (row) of pixels. Hence, the Hsynch signal 330 controls when the horizontal alignment of the refresh operation returns to the start of a new row, at the left hand side of the screen of the display device 110.

The Data signal 340 contains the data for each pixel of the display device. This data is divided into blocks, where each block represents a row on the display device. As shown in FIG. 3a and FIG. 3b, these blocks correspond to the Hsynch timing signal 330. Within each block, the pixel data is refreshed at a rate corresponding to the pixel clock 350.

Preferably in the first embodiment, the HSynch signal 330 and the pixel clock 350 are substantially fixed, with only the VSynch signal 320 varied to control the rate of

refresh (noting that the Data signal is dependent upon each of the other three timing signals). However, it is within the contemplation of the invention that other devices may be refreshed in response to varying one or more of the, or other, timing signals, such that the time it takes for a single refresh cycle can be altered. For example, the pixel clock timing can be adjusted, with a longer clock-pulse duty cycle consequently creating a longer display refresh operation.

In this manner, instead of controlling the period of time (pause 322 in FIG. 3a) *between* each refresh cycle in order to vary the refresh rate, the period of time taken for each individual refresh operation can be controlled to vary the refresh rate. An example of this is shown in FIG. 3b, which highlights a timing arrangement 360 indicating a longer refresh operation. The longer refresh operation is achieved by controlling Vsynch 320 to have a much reduced 'low-period', thereby providing a much reduced pause period of time 323, compared to the pause period 322 of FIG. 3a. Since the time taken for each refresh cycle can be varied, it may not therefore be necessary to implement a 'pause' between each refresh cycle.

Hence, the present invention provides a means of varying a display refresh rate depending on the image being displayed. Such a variable display refresh mechanism allows the cellular subscriber unit (or other video or image device) to dynamically optimise the power consumption of a display device with respect to the power

required to facilitate image refreshing on a display. This is more clearly shown with reference to the graph 400 of FIG. 4.

The graph 400 of FIG. 4 illustrates how the refresh rate 420 affects the power consumption 410 of the display device. In order to keep the power consumption to a minimum it is necessary to have as low a refresh rate as possible. Therefore, a reduction in the refresh rate provides a comparable, but generally non-linear, reduction in the power consumption of the display device 110 as shown by curve 430.

Referring back to FIG. 1 for completeness, the transmit chain of the cellular subscriber unit 100 essentially includes an input device 120, such as a keypad, coupled in series through transmitter/modulation circuitry 122 and a power amplifier 124 to the antenna 102. The transmitter/ modulation circuitry 122 and the power amplifier 124 are operationally responsive to the controller.

Of course, the various components within the cellular subscriber unit 100 can be realised in discrete or integrated component form. Furthermore, it is within the contemplation of the invention that any device capable of displaying received video or images can benefit from the inventive concepts described herein.

In accordance with the preferred embodiment of the present invention, the decision as to whether to dynamically adapt the display refresh rate is made in response to any one or more of a number of image parameters related to the image to be displayed. One such preferred image parameter is the number of colours to be used in displaying the image, as shown in FIG. 5.

The graph 500 of FIG. 5 illustrates how the power consumption 510 of the display device is affected by the number of colours 520 to be displayed. In order to keep the power consumption to a minimum it is necessary to have as few colours as possible. Therefore, a reduction in the number of colours to be used provides a comparable, but generally non-linear, reduction in the power consumption of the display device 110 as shown by curve 530.

An example of a technology capable of performing such colour selection is MPEG compression - one of the International Standard Organisation's (ISO) standards for video encoding. The ISO MPEG4 standard contains tools for individually coding video objects, their shape and their composition in an audio-visual scene.

An alternative image parameter that could be used, for example, is to determine the number of pixels that have been changed between consecutive frames, by say employing a frame-by-frame comparison of the image. The primary consideration in the selection of a suitable image

parameter is that it has a direct relationship with the refresh requirements of the image to be displayed. It is therefore within the contemplation of the invention that a person skilled in the art could readily use the teachings of the present invention with any other parameter(s) related to the image to be displayed.

The primary design consideration in the preferred embodiment is the selection of an optimum refresh rate for the display, to avoid any perceptual flickering of the displayed image to the display viewer/user. As such, a maximum allowable flicker of the displayed image can be determined, as illustrated in the graph 600 of FIG. 6. The selected maximum allowable flicker rate is preferably imperceptible to the user of the display. The graph 600 shows that as the number of colours 620 increases, so does the amount of flickering 610. In order to keep the flicker 610 below a particular maximum flicker level 640, when displaying an increased number of colours, it is necessary to have a comparable increase in the refresh rate to maintain the same flicker level, as shown by curves 630. This relationship is shown more clearly in FIG. 7.

Referring now to the graph 700 of FIG. 7, a graphical relationship 730 between the number of colours 720 in an image to be displayed and the optimum refresh rate 710, required in order to substantially avoid flickering, is illustrated. Such a graph (or indeed arithmetic

function) could be provided by either the manufacturer of the display device, or produced through testing of the device to determine typical or worst-case user perception levels for different flicker rates.

For the preferred embodiment of the present invention, the values in the graph 700 (or arithmetic function) are used to create a lookup table in the memory device 116, as illustrated in Table 1.

Table 1:

Number of colours in the picture	Refresh rate (Hz)
8	12
16	17
32	21
64	25
128	29
256	33
512	37
1,024	42
2,048	46
4,096	50
8,000	54
16,000	58
32,000	62
65,000	66

Once the aforementioned graph (or arithmetic function) has been downloaded to the cellular subscriber unit 100, it is preferably stored in the memory device 116 of FIG. 1. The memory device 116 could be either a read-only memory (ROM), in which case the data is fixed for that memory device, or random access memory (RAM) in which case the data can be adaptable for different image formats or different communication devices (for example black and white images on a closed circuit television (CCTV) link).

The graph (or arithmetic function) can then be executed by the processor 108 and/or controller 114 of the cellular subscriber unit 100 to vary optimally the refresh rate of the screen or flat panel display 110.

Referring now to FIG. 8, a flow diagram 800 is shown of the preferred method of the present invention for varying a refresh rate associated with a video or image frame. An image is received for displaying on a display, as shown in step 810. An algorithm processes the image to be displayed, and extracts image parameter data, in order to determine an optimum refresh rate, as in step 820. The optimum refresh rate is selected such that the power consumption is kept to a minimum without there being any noticeable flickering to the display user/viewer.

In the preferred embodiment, the algorithm in step 820 uses a lookup table to determine the optimum refresh rate

for the image being displayed. Alternatively, as indicated above, the algorithm could use an arithmetic function, representative of the aforementioned lookup table in order to determine an optimum refresh rate.

A display driver, preferably controlled by a processor or controller, uses the output of the algorithm to determine optimum timing parameters for refreshing the image on the display, for example Vsynch, Hsynch, pixel clock, as shown in step 830.

The display driver then controls the image refresh operation of the display, using the above timing parameters, in order to maintain a particular perceived quality of displayed image, as in step 840.

It is within the contemplation of the invention that a cellular subscriber unit 100 (or other video/image device) may be re-programmed with an algorithm supporting the inventive concepts of the present invention, as described above. More generally, according to the preferred embodiment of the present invention, such re-programming to dynamically adapt a refresh rate of a display may be implemented in a respective cellular subscriber unit 100 (or other video/image device) in any suitable manner. For example, a new memory chip may be added to a conventional cellular subscriber unit 100 (or other video/image device).

Alternatively, existing parts of a conventional cellular subscriber unit 100 (or other video/image device) may be

adapted, for example by reprogramming one or more processors therein. As such the required adaptation may be implemented in the form of processor-implementable instructions stored on a storage medium, such as a floppy disk, hard disk, programmable ROM (PROM), RAM or any combination of these or other storage multimedia.

Referring now to FIG. 9, a flow chart 900 describes the algorithm in step 820 of FIG. 8 in more detail, in accordance with the preferred embodiment of the present invention. The algorithm includes receiving image data, as in step 910. The algorithm proceeds to process the received image data to determine a value for selected image parameters relating to the image to be displayed, as shown in step 920.

For example, in accordance with the preferred embodiment, the maximum number of colours (say 512) in the image to be displayed is determined. The algorithm then checks this value with the lookup table to define the optimum refresh rate required to avoid flickering (which in the above case is 37 Hz), as in step 930. The optimum refresh rate for the image parameter value is then used by the display driver to determine the required timing signals to be used to update/refresh the image on the display.

Whilst the image to be displayed remains the same, the algorithm maintains the same minimum refresh rate, as shown in step 940. However, when the image changes, the

algorithm receives data for the new image, and the process repeats, as shown.

It is within the contemplation of the invention that the above image change may be a new image frame, or comprise a number of changed pixel values. Furthermore, it is within the contemplation of the invention that any number of alternative image evaluation techniques may be used to obtain the image parameters that are best suited to determine the optimum refresh rate.

It will be understood that the display refresh operation described above provides at least some of the following advantages:

(i) The refresh rate is constantly being varied in response to the images being displayed so as to keep the power consumption of the display device to a minimum without noticeable flickering of the display device to the display viewer/user.

(ii) The quality of the image may be maintained at a continuous level, irrespective of the changes in, for example the complexity or number of colours used in, a particular image.

(iii) Power consumption of a display device is dynamically optimised whilst maintaining a given quality of image.

Thus an improved display arrangement has been described wherein the aforementioned disadvantages associated with prior art approaches have been substantially alleviated.

Claims

1. A method of refreshing an image on a display, the method comprising the steps of:

receiving an image to be displayed at a display;

processing said received image to obtain at least one image parameter relating to said image to be displayed; and

varying a rate at which said displayed image is refreshed based on said image parameter.

2. The method of refreshing an image on a display according to claim 1, wherein the step of varying further includes the step of:

optimising a power consumption level of the display whilst maintaining a quality level of the displayed image.

3. The method of refreshing an image on a display according to claim 1 or claim 2, wherein the step of varying a refresh rate includes at least one of: varying a refresh duty cycle, varying a rate of pixel refresh.

4. The method of refreshing an image on a display according to any preceding claim, wherein the step of varying a refresh rate includes varying a timing signal associated with the image to be displayed.

5. The method of refreshing an image on a display according to any claim 4, wherein varying a timing signal includes varying at least one of the following timing

parameters: a vertical synchronisation, a horizontal synchronisation, data, pixel rate.

6. The method of refreshing an image on a display according to claim 5, wherein the step of varying a refresh rate includes the step of:

varying a timing of pulses of the vertical synchronisation signal, thereby controlling a duty cycle of a refresh operation.

7. The method of refreshing an image on a display according to any preceding claim, wherein the at least one image parameter relating to said image to be displayed includes a number of colours in an image to be displayed.

8. The method of refreshing an image on a display according to any preceding claim, the method further comprising the steps of:

using a lookup table or an arithmetic function relating to the at least one image parameter in order to select an improved refresh rate.

9. The method of refreshing an image on a display according to claim 8, wherein the lookup table provides an optimum refresh rate to avoid any perceptual flickering of said displayed image.

10. The method of refreshing an image on a display according to any preceding claim, wherein the refresh

rate is dynamically adapted when a new image or portion of an image to be displayed is received at said display.

11. The method of refreshing an image on a display according to any preceding claim, the method further comprising the step of:

refreshing an image to be displayed by refreshing at least one of:

a portion of an image
a full-screen image,
an image by means of a row-by-row refresh
an image by means of an interleave

refresh operation.

12. An image or video communication device, adapted to perform any of the steps of method claims 1 to 11.

13. The image or video communication device according to claim 12, wherein the device is one of:

a cellular phone, a portable or mobile radio, a personal digital assistant, a laptop computer, a wirelessly networked PC.

14. A display driver for controlling the refresh rate of a display device, adapted to perform any of the steps of method claims 1 to 11.

15. A storage medium storing processor-implementable instructions for controlling one or more processors to carry out the method of any of claims 1 to 11.

16. A video or image display device, the device comprising:

a display for displaying an image;

a processor, operably coupled to said display, for processing said received image to obtain at least one image parameter relating to said image to be displayed; and

means, operably coupled to said processor, for varying a rate at which said displayed image is refreshed based on said image parameter.

17. The video or image display device according to claim 16, wherein the means for varying a refresh rate includes at least one of:

means for varying a refresh duty cycle, means for varying a rate of pixel refresh.

18. The video or image display device according to claim 16 or claim 17, the device further comprising a timer operably coupled to said processor for varying a timing of a refresh rate by varying a timing of a refresh control signal associated with the image to be displayed.

19. The video or image display device according to claim 18, wherein the timer varies at least one of the following timing parameters relating to said display: a vertical synchronisation, a horizontal synchronisation, data, pixel rate.

20. The video or image display device according to claim 19, wherein the timer varies a timing of pulses of

the vertical synchronisation signal, thereby controlling a duty cycle of a refresh operation.

21. The video or image display device according to any of claims 16 to 20, wherein the at least one image parameter relating to said image to be displayed includes a number of colours in an image to be displayed.

22. The video or image display device according to any of claims 16 to 21, the device further comprising a memory device, for example comprising a lookup table or an arithmetic function, that stores information relating to the at least one image parameter.

23. The video or image display device according to claim 22, wherein the memory device provides an optimum refresh rate to avoid any perceptual flickering of said displayed image.

24. The video or image display device according to any of claims 16 to 23, wherein the means for varying a refresh rate is responsive to the display receiving a new image or portion of image to be displayed.

25. The video or image display device according to any of claims 16 to 24, wherein said image on said display is refreshed by refreshing at least one of:

a portion of an image,

a full-screen image,

an image by means of a row-by-row refresh,

an image by means of an interleave refresh operation.

26. A display driver adapted to control the refresh rate of a display device according to any of claims 16 to 25.

27. A video or image communication device substantially as hereinbefore described with reference to, and/or as illustrated by, FIG. 1 of the accompanying drawings.

28. A method of refreshing an image on a display substantially as hereinbefore described with reference to, and/or as illustrated by, FIG. 8 or FIG. 9 of the accompanying drawings.

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Application No: GB 0119002.4
Claims searched: 1, 12, 14 -16, 26

Examiner: Sue Willcox
Date of search: 8 February 2002

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H4F FCW; H4T TABL

Int Cl (Ed.7):

Other: Online databases: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 1073269 A	(THOMSON) - see abstract	1, 12, 14 - 16, 26 at least
X	EP 0852371 A1	(HITACHI Ltd) - see abstract and col. 5, line, 51 - col.6, line 41	1, 12, 14 - 16, 26 at least
X	US 6037919	(HANSON) - see whole document	1, 12, 14 - 16, 26 at least
X	US 5991883	(ATKINSON) - see cols 5 - 6, condition D	1, 12, 14 - 16, 26 at least
X	US 5583530	(MANO *et al*) - see abstract and col. 8, line 26 *et seq*	1, 12, 14 - 16, 26 at least
X	JP 9261638 A	(MATSUSHITA) - see abstract	1, 12, 14 - 16, 26 at least
X	JP 8163556 A	(CANON KK) - see abstract	1, 12, 14 - 16, 26 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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